Quarterly Report

Contract Number NB84 RAC 45036

Study of the Use of Radioactive Trace Elements in Welding Consumables for Detection of Cracking and Corrosion in Offshore Structures and Pipelines

Submitted to:

Dr. Harry McHenry
National Bureau of Standards
325 Broadway
Boulder, CO 80303

Submitted by:

Dr. Jerry E. Jones
and
Dr. Charles A. Natalie
Center for Welding Research
Colorado School of Mines
Golden, Colorado 80401

December, 1984

During the past quarter, the primary efforts associated with this project have been devoted to determining the constraints placed on this nondestructive testing methods by radiation safety requirements, an investigation of the potential problems associated with in-situ radiation of the welds and heat-affected zones and welding of additional testing samples with elevated levels of chemical tracers for diffusion experimentation.

Radiation Safety Requirements

The federal regulations covering radiation safety and establishing the allowable exposure to radiation and the required amount of shielding are covered in the Code of Federal Regulations, Title 10-Energy, Chapter 1, Part 20 entitled "Standards for Protection against Radiation". This regulation covers permissible doses, levels, and concentrations; precautionary procedures; waste disposal; records, reports, and notification; and enforcement. Each of these, however, is variable and depends on the required concentration and activity of radioisotopes. The concentration of radioisotopes is yet to be determined, but will be established as a final result of this initial project.

Preliminary arrangements have been made with Los Alamos National Laboratory for in-situ irradiation of a weldment. Such a weld would be fabricated with a desired distribution of a non-radioactive tracer and then to transform that non-radioactive tracer into the desired radioactive tracer. One potential problem encountered is the formation of Fe-55, a beta-emitting radioisotope with a half-life of 2.6 years that forms when alloys containing iron are subjected to a neutron flux. If inspection then takes place before this isotope has decayed sufficiently, the detector may detect the Fe-55 beta emissions and mistake them for emissions of the intentional tracer addition thereby producing false indications. This problem may be eliminated by irradiating the welds prior to welding the final layer of passes, perhaps the final passes would be welded with some sort of automated or robotic system to reduce welder exposure to radiation. If this is done, the final layer of passes will be largely free of radioisotopes, giving the desired distribution of tracers.

Expansion of Test Matrix

In order to better model the diffusion of the chemical tracers into the environment from the crack, welds with higher levels of tracer metals have been produced and included in the test matrix. A commercially available maraging steel welding electrode was selected and welding is now completed. In order to prevent hot-cracking of the weld passes, a great deal of experimentation to establish proper welding parameters was necessary and parameters of 24V, 320A, and a travel speed of 55 inches per minute have proven acceptable.

Mathematical Modeling

A mathematical model is being developed which will predict the sensitivity of the proposed detection method to various tracer metals. The model will predict the flux of tracer from a crack opening based on steady state diffusion. The solubility data obtained in the first quarter of this project will be used in the model. After calculation of the flux of tracer, a comparison will be made with the required flux given the detection limits of current radiation measurement technology.